REPORT ON THE

SODA LAKE, NEVADA

GEOTHERMAL PROSPECT

by

WALTER R. BENOIT

AUGUST, 1980

DISCLAIMER

DISCLAIMER

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

INTRODUCTION

During the past six years at the Soda Lake Geothermal prospect there has been much deeper drilling and several geophysical surveys have been conducted. Chevron and Phillips have drilled two geothermal test wells and seven strat. tests ranging from 1300 feet to 3500 feet in depth. A re-interpretation of this existing temperature data has resulted in a new thermal model of the area which suggests that two geothermal reservoirs could be present. With the available data it is possible that each reservoir could cover over three square miles. This report was written to present this new model, make available the significant existing data, and to justify additional deep well expenditures in the area.

Additional expenditures at Soda Lake are necessary in the near future. The Soda Lake unit does not have a unit well yet. In order to maintain the unit and not have a new land chargability problem in Nevada it is necessary that a unit well be drilled in the near future.

TEMPERATURE GRADIENT DATA

Shallow Temperature-Gradient Holes

Chevron, Phillips and the U.S. Geological Survey have drilled numerous shallow temperature-gradient holes in the Soda Lake area. Information on these shallow holes is shown on Tables 1, 2, and 3. These holes are shown on the Temperature-Gradient Map (Plate 1), the 100' Depth Isothermal Map (Plate 2) and the 500' Depth Isothermal Map (Plate 3). All three plates show nearly identical patterns. A small, extremely intense anomaly is located near the center of a much larger, and still significant, thermal anomaly. The small intense anomaly covers about two square miles. Deeper drilling has shown that the extremely high near-surface temperatures in this anomaly are the result of thermal water ascending near the surface. Therefore, the temperature gradients in this area are simply shown as unprojectable on the temperature-gradient map (Plate 1). The temperature-gradient map shows an area of about 19 square miles to be underlain by temperature gradients exceeding $6^{\circ}F/100'$. About six square miles of land are underlain by temperature gradients exceeding $10^{\circ}F/100'$.

Experience at Desert Peak, Humboldt House, Steamboat, Soda Lake, and San Emidio has shown that deep wells located in areas where the near-surface thermal gradient greatly exceeds $10^{\circ}F/100'$ are likely to be unsuccessful.

Deep Wells

Two deep wells have been drilled in the Soda Lake Prospect. Equilibrium profiles for both wells are shown on Plate 4. The first deep well, 29-1, was located in the heart of the small intense thermal anomaly. It was drilled in 1974 before the strat. test technique had evolved and is best remembered as a learning experience rather than an avoidable failure. This well has a temperature reversal at a depth of 800 feet and has a bottomhole temperature of $340^{\circ}F$. Two drill stem tests were performed on this well between intervals of 800'- 980'

TABLE 1

SHALLOW TEMPERATURE-GRADIENT DATA AT SODA LAKE

Phillips Shallow Temperature-Gradient Holes

Hole#	Depth (Feet)	Gradient (°F/100')	Depth Interval (Feet)	Isothermal Data (°F) 50'	100'	200'	500'
SL-1	490	4.5	100 - 480	63	66	70	83
SL-2	500	8.9 10.0	100 - 400 400 - 500	62	65	74	102
SL-3	500	decreasing 10.4	100 - 340 340 - 500	73	81	91	117
SL-4	500	8.6 10.56	100 - 250 250 - 500	69	72	80	111
SL-5	500	irregular		64	66	76	138
SL-6	500	3.5	100 - 500	63	65	68	79
SL-8	500	3.8	100 - 500	63	65	69	80
SL-13	500	3.0	100 - 500	63	64	67	76
SL-14	500	8.0 4.5	100 - 250 250 - 470	66	71	79	93
SL-15	500	8.2 10.0	100 - 300 300 - 500	67	72	79	108
SL-16	500	9.3 10.8	100 - 250 250 - 500	66	70	79	111
SL-17	500	2.0	100 - 500	62	63	65	71
SL-18	500	3.8	100 - 500	61	63	66	78
CS-22	300	4.1	100 - 290	64	66	71	

TABLE 2

SHALLOW TEMPERATURE-GRADIENT DATA AT SODA LAKE

Chevron Shallow Temperature-Gradient Holes

Hole#	Depth (Feet)	Gradient (°F/100')	Depth Interval (Feet)	Isothermal Data (°F) 50'	100'	200'	500'
SL-C-4	108			57.3	58.2		
SL-C-5	109			60.2	61.1		
SL-C-6	109			57.2	59.0		
SL-C-27	484	5.8	100-484	61.7	66.2	72	89
SL-C-28	465	8.1	100-465	66.9	70.8	78	103
SL-C-29	472	9.6	140-472	65.4	73.5	84	113
SL-C-30	484	58 isothermal	200-400 400-484	73.6	86.7	122	237
SL-C-31	500	6.5	100-500	63.7	66.3	73	92
SL-C-32	484	5.1	100-484	61.3	64.6	70	85
SL-C-33	484	1.3 7.3	100-400 440-484	59.8	60.1	61	70
SL-C-34	484	3.2	300-484	61.3	63.4	66	76
SL-C-35	484	9.2	100-484	66.4	70.9	79.9	107

TABLE 3

SHALLOW TEMPERATURE-GRADIENT DATA AT SODA LAKE

U.S.G.S. Shallow Temperature-Gradient Holes

Hole#	Depth (Feet)	Gradient (°F/100')	Depth Interval (Feet)	Isothermal Data (°F) 50'	100'	200'	500'
2	136			59	63		
3	93			67	70		
4	170			109	138		
5	85			80	91*		
6	147			67	72		
9	130			61	63		
10	76			63			
12	66			60			
14	66			56			
17	150			68	78		
18b	490	1.4 4.5	100 - 320 320 - 490	64	64	67	78
19	150			93	113		
20	500	irregular isothermal	100 - 440 440 - 535	185	227	264	292
21	146			136	167		
22	120			159	201		
23	130			63	63		
25	133			62	64		
26	76			144	>200		
27	130			90	101		
28	150			76	78		
29	47			138			

* Projected

TABLE 4

SODA LAKE STRAT. TEST AND DEEP TEST INFORMATION

Hole #	Depth	Collar Elevation	Depth Elevation	Temperature °F 500'	1000'	1500'	2000'	Bottomhole Gradient	Estimated Depth 350°F	Estimated Depth 400°F
Hoenig	2000'	3980'	1980	156	177	194	212	3.46°F/100'	6000'	7400'
Orowitz	1300'	4000'	2700	91	122	161*	200*	6.3 °F/100'	4600'	5400'
11-33	2000'	3980'	1980	338	341	361	371	1.6°F/100'	1300'	3900'
36-78	1966'	3980'	2024	273	292	310	336*	3.7°F/100' 5.4°F/100'	2400' 2300'	3700' 3200'
63-33	2000'	3980'	1980	189	222	265	307	8.0°F/100'	2500'	3200'
62-33	3000'	3980'	980	193	223	259	292	6.0°F/100'	3000'	3800'
58-34	3500'	3990'	490	106	152	171	197	?	3900'	4500'
29-1	4270'	3980'	-290	266	319	305	309	1.7°F/100'	4800'	7800'
44-5	5020'	4000'	-1020	83	104	115	128	4.2°F/100'	7600'	8800'

* Projected

and 1008'-1530' and water samples were recovered. These samples will be discussed further in the geochemistry section. Well 29-1 bottomed in a hard pre-Tertiary metadiabase or metadiorite. At the present time there is no reason to deepen this well. This well should be flow tested to obtain better water and gas samples and to measure its flow rate and characteristics.

Well 44-5 was drilled late in 1977 and was in nearly every respect unsuccessful. The well location, almost outside the thermal anomaly, reflects the fact that it was located on a faulty geologic model based primarily on questionable geophysics. The well was apparently located by Chevron not with the hope of intersecting a geothermal reservoir, but with the idea of proving that seismic studies are capable of locating poorly exposed faults. This well apparently bottomed in Tertiary volcanics. This suggests that this area is structurally lower than 29-1 which apparently bottomed in Mesozoic rocks. In hindsight neither deep well is properly located to test the two deep thermal anomalies.

Strat. Tests

To date seven strat. tests have been drilled in the Soda Lake area. Data from these strat. tests are shown on Table 4. Equilibrium temperature profiles from the strat. tests are shown on Plate 4. The strat. test profiles show that the very high near-surface temperature gradients cannot be projected below depths of 400 to 800 feet. The area of unprojectable gradients shown on Plates 1 and 5 is based primarily on the temperature profiles shown on Plate 4.

To date the small intense thermal anomaly, where near-surface thermal gradients greatly exceed $10^{o}F/100'$, has been thoroughly evaluated. One deep well (29-1) and three strat. tests (36-78, 11-33, and Hoenig) are located within this two square-mile area (Plate 1). Strat. tests 63-33 and 62-33 are located just outside the intense anomaly. Deep well 44-5 has evaluated a part of the outer edge of the thermal anomaly. The Orowitz strat. test and strat. tests

62-33, 63-33, and 58-34 have partially evaluated the more promising parts of the near-surface thermal anomaly.

Estimated Depth to 400°F

At Soda Lake there is some good evidence which suggests near-surface temperature gradients of 10-12°F/100' or less can be fairly accurately extrapolated to greater depths. The temperature profile of the Orowitz strat. test is a linear 6.3°F/100' from 50 feet to the total depth of 1300 feet (Plate 4). Well 44-5 has shown that the low temperature gradients outside the 6°F/100' contour give an accurate indication of temperature at depth. Extrapolating the temperature-gradient found above a depth of 500 feet in strat. test 58-34 gives an error of only 700 feet when compared with the measured temperature at 3500 feet. This is regarded as acceptable accuracy in this kind of analysis. Strat. test 63-33 is also fairly linear. The deviation from linearity near the top appears to be due to its proximity to the intense thermal anomaly.

Now that it has been shown that it is possible to selectively extrapolate shallow temperature gradients to greater depths a new map can be prepared which is significantly different from Plates 1, 2, and 3. This map (Plate 5) shows the estimated depth to the 400°F isotherm. A temperature of 400°F was chosen because the chemical geothermometers suggest this is close to the reservoir temperature. Also strat. test 11-33 has a measured bottomhole temperature of 371°F at 1998' and the temperature gradient is still positive so it is reasonable to expect temperatures near 400°F at depths less than 6000-8000 feet. Plate 5 was constructed by simply extrapolating the temperature gradients present at the bottoms of the holes. This data from the strat. tests and deep wells are shown on Table 4. The shallow temperature gradients were also extrapolated when the holes are deeper than 460 feet and the bottomhole temperature gradient is less than 11°F/100'. The only exception to this is hole CS-22 which is 300' deep. The estimated depth to

400^{o}F from the shallow holes can be easily calculated from data on Tables 1, 2, and 3.

Plate 5 suggests that there are two separate deep thermal anomalies, one centered on section 20, the northwest anomaly, and one centered on section 34, the southeast anomaly. Both anomalies appear to cover more than three square miles. The northwest anomaly contains only the Orowitz strat. test. So by no means has this anomaly been adequately evaluated. Two or three additional strat. tests are needed in the future. The southeast anomaly has been partially evaluated by strat. tests 62-33, 63-33 and 58-34. These strat. tests have provided enough encouraging data to pick a location for a deep test. If the deep test is successful then additional strat. tests will be necessary to further outline the southeast anomaly.

If this model is correct then the two anomalies are separated by a relatively thin, cold, septum which extends from Soda Lake to Upsal Hogback. This is clearly shown on Plate 6, a Temperature Cross Section from the Orowitz strat. test to strat. test 58-34. Plate 6 suggests that the intense portion of the near-surface thermal anomaly is caused by thermal water rising to the west out of the deep southeast thermal anomaly. It seems ironical that this thermal water makes its closest approach to the surface directly over the cold septum separating the two deep thermal anomalies.

Plate 5 admittedly is speculative and a few words of caution are in order. First, the estimated depths are probably minimum depths. With increasing depth the thermal conductivity of the rocks should increase resulting in a lower temperature gradient and therefore, greater depths to the 400^{o}F isotherm. Second, this model is based on relatively few and often shallow data points. There is a slight possibility that thin sub-horizontal thermal aquifers at depths greater than 3000 feet could be controlling parts of the contour pattern on Plate 5. This possibility is felt to be slight for the following reasons. First the temperatures at the bottom of strat. tests 11-33, 36-78, and 62-33 are all near or over 350°F. With only 50°F more needed to reach the estimated reservoir temperature there is relatively little distance for severe complications to be present. Secondly below a depth of 3000' only one thin subhorizontal thermal aquifer has been found to date in northwestern Nevada. This is in Desert Peak B23-1 and the reservoir was present below this aquifer. This model cannot predict the presence of permeability at depth. It is simply assumed or hoped that the heat is present in the area because fractures in the rock have allowed thermal water to flow into the area.

GRAVITY

In the Soda Lake area regional gravity surveys have been run by the U.S. Geological Survey and Phillips Petroleum Company. Chevron has run a detailed survey.

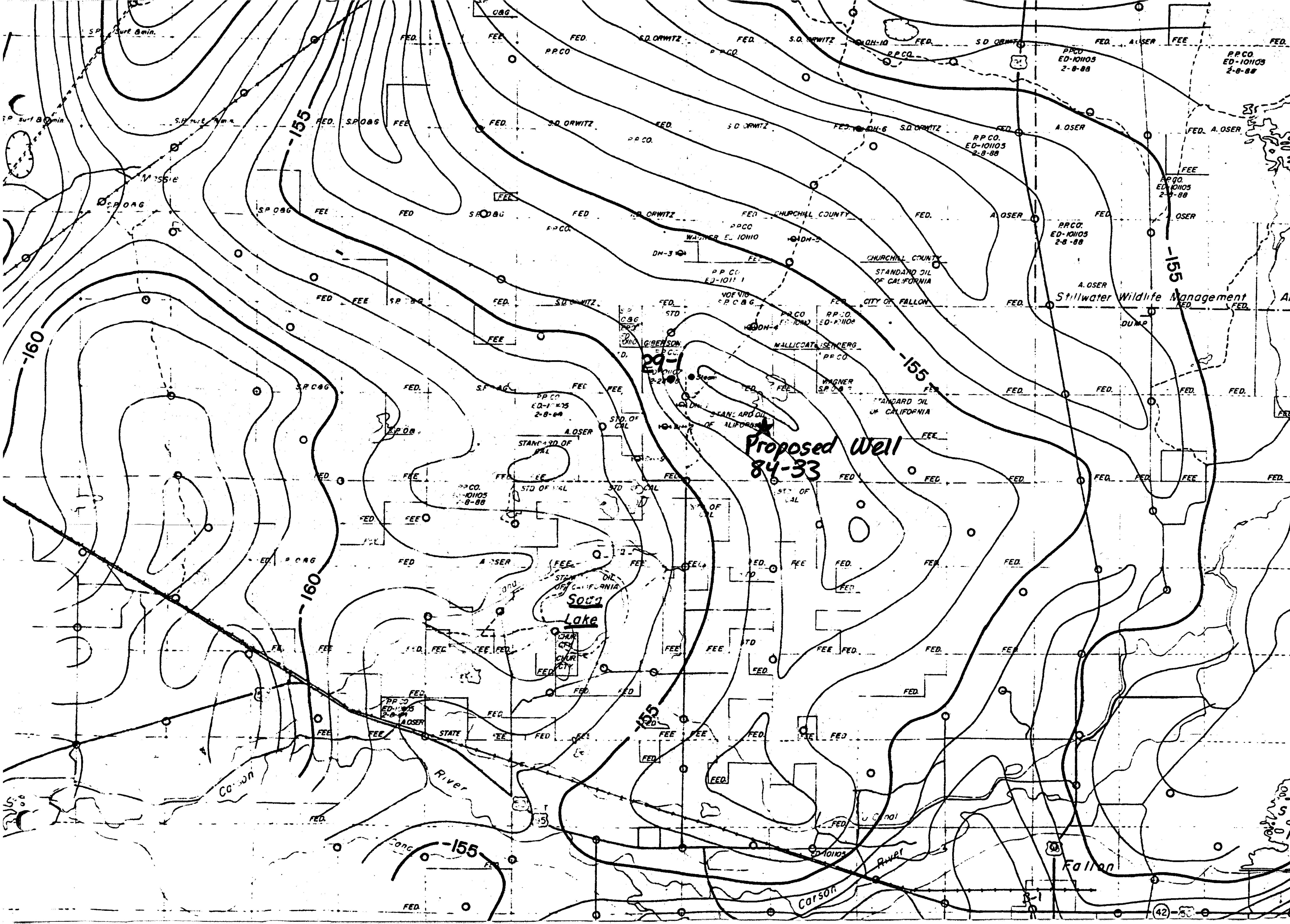
The U.S. Geological Survey Bouguer Map shows very little character in the Soda Lake area. A gravity low is shown to the west of Soda Lake. There is no hint of northeasterly trending structures on this map which would correlate with known northeasterly geologic structures.

Both the Phillips and Chevron gravity surveys (Figures 1 and 2) show a pronounced northwesterly trend through sections 19, 20, 28, 29, 33 and 34. This trend is a gravity high of about five milligals. This high may be caused by several features. Perhaps the two most significant origins in terms of geothermal exploration are 1) the high reflects a sub-surface structural high or 2) the high is caused by densification of the Tertiary and/or Quaternary sediments by geothermal processes.

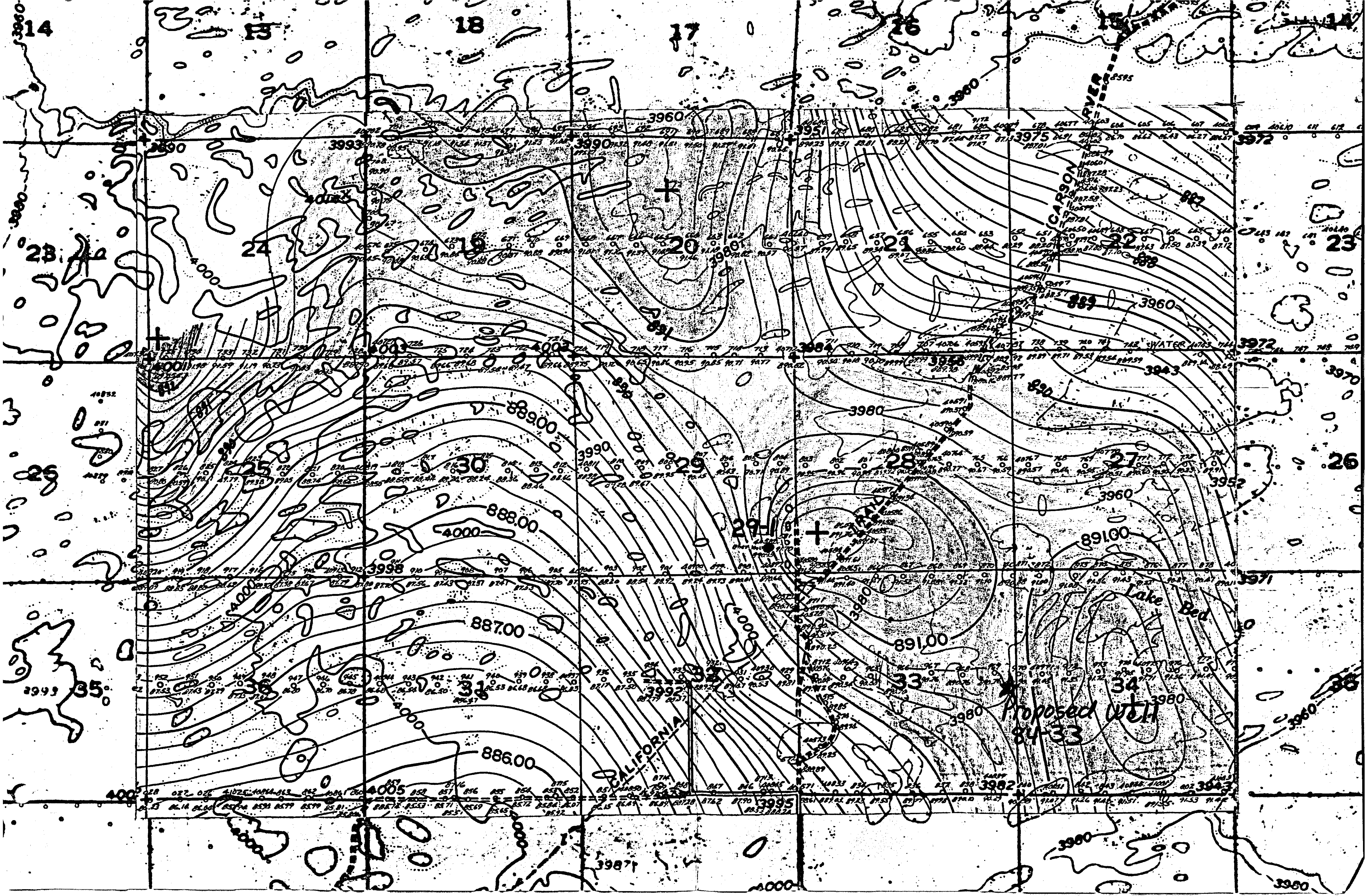
Wells 29-1 and 44-5 do provide some evidence that at least part of the anomaly could be the result of local variation of the depth to bedrock. In the bottom of well 29-1 a fine-grained fairly mafic intrusive unit is present. It is suspected that the rocks below 3930' in well 29-1 are pre-Tertiary in age. In contrast the rocks present in the bottom of well 44-5 are Tertiary volcanics and sediments. Therefore, it is possible that the gravity high is reflecting a structural high. On the detailed Chevron map the trend of the gravity high is in a northwesterly direction. Phillips gravity map, however, suggests this might be the tail of a larger north-northeasterly trending anomaly.

To date there is no evidence of densification of the Tertiary sediments. Silicification or other metamorphic processes have not yet been noticed in the cuttings from the strat. tests and deep wells. However, calculations by Chevron personnel suggest that the gravity anomalies in section 20, 28 and 34 are the result of density contrasts above a depth of 2000 feet. Therefore, at the present time the origin of the gravity anomalies is still speculative.

There appears to be a good correlation between the gravity highs and the temperature data on a fairly small scale.



Proposed Well
84-33
29-1
-155
-160
Soda
Lake
Carson River
Fallon
Stillwater Wildlife Management Are
CHURCHILL COUNTY
STANDARD OIL OF CALIFORNIA
CITY OF FALLON
A. OSER
S.D. ORWITZ
P.P.CO.
ED-101105
2-8-88
FED.
FEE
S.P. O&G
DUMP
WAGNER
DH-3
DH-4
DH-5
DH-6



14
15
18
17
16
15
14
23
24
19
20
21
22
23
25
30
29
28
27
26
35
36
31
32
33
34
35
CARSON RIVER
CALIFORNIA
Lake Bed
WATER
Proposed Well
84-33
29-1
889.00
888.00
887.00
886.00
891.00
891.00
3960
3972
3972
3971
3943
3993
3990
3951
3975
3984
3998
4005
3995
3982
3992
3980
3990
4000
3987

SEISMIC

During April and May 1975 a shallow reflection seismic survey was run by Charles B. Reynolds and Associates for Chevron. The source mechanism for this survey was a 300 pound steel ball dropped free-fall for 3.4 feet. The results of this survey are available at the Reno office. The data collected from this survey are of very low quality and the subsequent interpretation is not realistic. It is felt that this survey should not be a part of any geologic interpretation of the area.

In 1977 Chevron ran three additional seismic lines of higher quality. This data is not available at the Reno office. Discussions with Chevron personnel indicate that this seismic data is of little or no value. Apparently the survey was not capable of defining the contact between the Tertiary and Pre-Tertiary rocks. This survey was run to locate the inferred fault which runs from Soda Lake to Upsal Hogback. After this survey was completed Chevron personnel apparently felt that the reservoir would be confined to this fault or intersections with crossing faults. Well 44-5 was then located to intersect this fault and was a total failure. This survey will not be used to locate deep drill holes in the future.

MAGNETOTELLURICS

Geotronics has performed an MT survey at Soda Lake for Chevron. Five MT sites have been made available to Phillips by Chevron. This data is available at the Reno office. These five sites are located in a northwest-southeast line through well 29-1 which corresponds well with the thermal cross section (Plate 6).

The MT composite resistivity cross section shows a near-surface zone of very low-resistivities to be present in the SE¼ of Section 29 and the NW¼ of section 33. This corresponds very well with the location of the previously discussed leakage from the southeastern thermal anomaly. Below this zone the resistivities show a progressive increase with depth. There is very little horizontal variation. In short this composite resistivity cross section shows no obvious targets between depths of 3000 and 9000 feet.

Discussions with Chevron personnel indicate that they have little confidence in the results of this survey. The primary problem appears to be very low resistivities at or near the surface in this playa environment.

GEOCHEMISTRY

The best thermal water samples available in the Soda Lake area are from the two drill steam tests of well 29-1. This water has been analyzed by three laboratories; Amtech, Skyline, and Geolabs. There is considerable variation between labs. The water is a moderately saline sodium-chloride water which is very similar to water from the Desert Peak reservoir and the Brady's area. Analyses of this water are shown on Table 5. The samples shown were collected near the end of the tests.

The standard silica, sodium-potassium, and sodium-potassium-calcium geothermometers give an indicated reservoir temperature of between 180 and 215°C (Table 6). The sodium-potassium predicted temperatures are the lowest, being between 174 and 205°C. At Desert Peak this geothermometer predicts temperatures lower than measured in the reservoir and it is also suspected to be occurring at Soda Lake where a temperature of 189°C has already been measured. This error may be due to an excess of sodium in the environment. The silica geothermometer predicts a temperature of from 205-210°C for the diluted samples. The Na-K-Ca geothermometer predicts temperatures between 200 and 215°C.

These geothermometers suggest that the reservoir temperature at Soda Lake is probably about 400°F. Experience at Brady's and Desert Peak suggests the geothermometers are fairly accurate in the Carson Sink area.

Three gas samples were collected by Chevron personnel during the drill stem tests. These samples are all 78-80% nitrogen and from 14 to 20% oxygen. One sample contained 5.61% CO_2 and .13% CH_4. This data suggests that the samples are primarily air and not from the reservoir.

TABLE 5

WATER ANALYSES FROM SODA LAKE 29-1

Drill Stem Test Interval	791'-980'		1008'-1531'		
Date:	May 24, 1975		May 23, 1975		
Time:	11:45 am	11:30 am	4:25 am	5:10 am	5:10 am
Volume produced before sample:	≈312 barrels		≈277 barrels		
Lab:	Amtech	Geolabs	Amtech	Skyline	Geolabs
Ca	105	86	71	130	86
Mg	1.07	1	.65	17	10
Na	1350	1520	1350	1400	1520
K	155	160	150	130	160
Cl	2360	2950	2440	2130	2850
SO_4	82.3	110	101	50	120
CO_3				30	25
HCO_3	175	105	152	105	135
B	10.6	10.0	10.7	11	10.0
Li	1.45	2.6	1.45	2.9	2.6
pH (lab)	8.15	8.4	8.45	8.8	8.6
Conductivity	9500	7800	9090	6460	7490
TDS		4740		4480	4900
Si (diluted 3:1)	290		(diluted 9:1) 670	450	
F		1.6		.18	1.9
As		.05		.12	.05

TABLE 6

GEOCHEMISTRY - SODA LAKE

(CHEMICAL GEOTHERMOMETERS)

Sample#	Ca(ppm)	Na(ppm)	K(ppm)	Na/K°C	Na-K-Ca°C B=1/3	Na-K-Ca°C B=4/3	Si°C
800-980'			Amtech Laboratories				
0700	98	1300	150	200	212.97	221.47	204(d)
0800	98	1300	155	205	215.02	223.59	205(d)
0900	90	1350	155	200	214.33	228.14	201(d)
1000	88	1350	155	200	214.56	229.13	208(d)
1100	82	1350	155	200	215.30	232.28	208(d)
1145	105	1350	155	200	212.73	221.43	206(d)
1008-1530'			Amtech Laboratories				
1615	44	1800	135	152	201.47	258.67	206
1940	64	1650	155	176	209.55	248.40	183
2030	68	1650	155	176	208.93	245.52	180
2110	72	1650	155	176	208.35	242.83	180
2215	71	1450	148	185	210.95	237.29	173
2335	71	1500	155	186	212.41	241.26	183
0055	64	1500	155	186	213.48	246.13	182
0210	78	1400	155	196	214.30	235.36	182
0315	72	1350	150	196	214.6	235.9	180
0425	71	1350	150	196	214.6	235.9	too high
			Skyline Laboratories (Chevron's samples)				
1	355	1710	170	183	196.6	183.3	177
2	210	1570	220	228	221.2	217.5	178
3	94	1550	180	202	217.5	239.42	too high
4	100	1490	160	192	211.1	227.77	193

TABLE 6 (continued)

Sample#	Ca(ppm)	Na(ppm)	K(ppm)	Na/K°C	Na-K-Ca°C B=1/3	Na-K-Ca°C B=4/3	Si°C
5	98	1410	160	197	213.3	227.6	209(d)
6	110	1500	150	183	205.9	219.58	182
7	115	1430	140	180	203.25	212.36	too high
8	130	1400	130	174	198.49	202.45	too high
9	105	1380	140	184	205.59	215.41	187
10	100	1350	130	178	202.51	212.35	182
11	100	1330	140	188	207.57	216.69	209(d)
12	98	1340	140	187	207.48	217.70	209(d)
			Geolabs (Chevron's samples)				
SL1-5	75	1600	160	183	211.14	242.43	211(d)
SL1-10	86	1520	160	188	211.85	234.96	210(d)
SL2-3	97	1480	160	192	211.71	228.96	
SL2-5	96	1480	150	184	207.85	225.16	205(d)
SL2-6	96	1500	160	190	211.26	229.72	207(d)
SL2-7	86	1520	160	188	211.85	234.96	209(d)

(d) means diluted sample

GEOLOGY

The subsurface geology in the vicinity of the two deep thermal anomalies is almost totally unknown. All the drill holes over these anomalies have bottomed in young unconsolidated sediments. All of the geophysical work is ambiguous and of little or no help in defining a geologic model. Until deep test wells are drilled in the deep thermal anomalies it is only possible to speculate on the nature of possible reservoirs. The drilling of additional 2000-foot deep strat. tests in these thermal anomalies will probably do nothing to increase the geologic knowledge of the area.

CONCLUSIONS

A re-interpretation of the existing temperature data at the Soda Lake geothermal prospect has produced a new and substantially different thermal model of the area. The last three strat. tests drilled (63-33, 62-33, and 58-34) have tested this model and produced very encouraging results. Previous work, with Chevron as the operator in the Soda Lake unit, had concentrated almost exclusively on the small very intense and misleading near-surface thermal anomaly. The new thermal model suggests that the 19-square-mile near-surface thermal anomaly overlies two separate deeper thermal anomalies. These deeper thermal anomalies appear to cover more than three square miles each. This means it is possible that one or even two large reservoirs remains to be discovered at Soda Lake. The model is based solely on temperature data.

The other geophysical and geological information obtained to date have not been very useful. At the present time it is not possible to construct a unique geologic model of the geothermal system at Soda Lake.

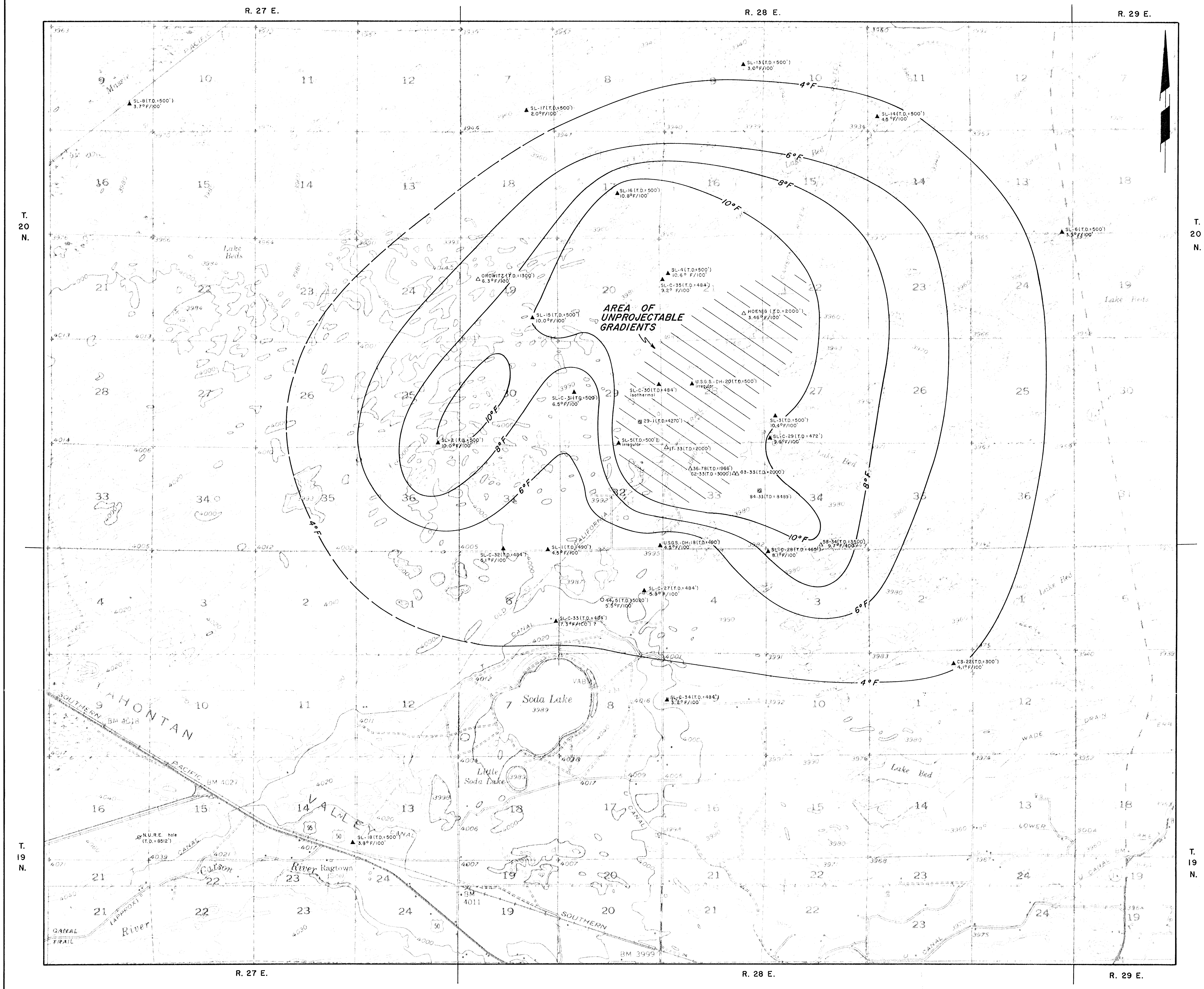
A limited amount of geochemical data in conjunction with strat. tests suggests that the reservoir will have a temperature near $400^{o}F$.

RECOMMENDATIONS

It is recommended that a deep test be drilled in SE¼ SE¼ NE¼ section 33, T20N-R28E. This is in the deep southeast thermal anomaly and is located between two deep and encouraging strat. tests. The proposed deep well is believed to be among the least risky wildcat geothermal wells drilled in Nevada. There is evidence to suggest that the reservoir at depth covers more than two square miles. The reservoir should be similar to all others discovered in Nevada with a temperature near 400°F and a rather dilute brine. Dry steam is certainly not present at Soda Lake.

At the present time additional strat. tests in the southeast thermal anomaly are unnecessary. However, if the proposed deep well is successful then two or three more strat. tests should be drilled in the southeast anomaly to pick the location for a second deep test. These strat. tests should not be greater than 2000 feet deep.

The northwest thermal anomaly is currently under evaluated. In the future two or three 2000-foot deep strat. tests should be drilled in sections 17, 20, 29 and 30, T20N-R28E. As the anomalies appear to be separate, work on this anomaly should proceed independently of the work in the southeast anomaly.



TOPOGRAPHIC BASE TAKEN FROM SODA LAKE 15' U.S.G.S. QUADRANGLE

REVISIONS		DATE
UPDATED	TMP	4/80
UPDATED	JAH	12/81

▲ TEMPERATURE - GRADIENT HOLE
△ TEMPERATURE PROBE, STRAT. TEST
⌀ ABANDONED LOCATION
⊠ SHUT IN PRODUCER
○ LOCATION OR DRILLING WELL

2000' 0 2000' 4000' 6000' 8000'
SCALE 1" = 2000'

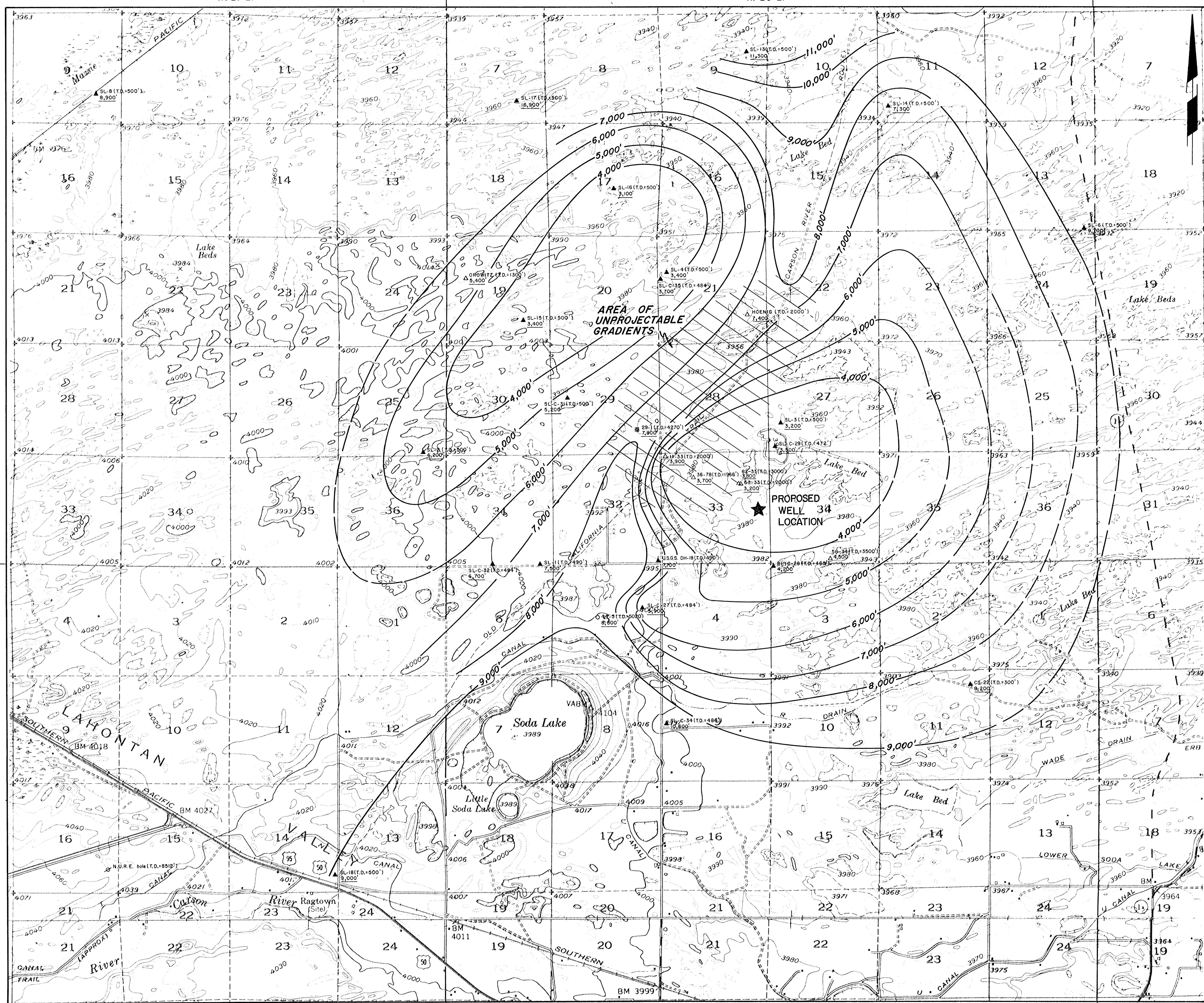
PHILLIPS PETROLEUM COMPANY
BARTLESVILLE, OKLAHOMA
NATURAL RESOURCES GROUP
ENERGY MINERALS DIVISION

TEMPERATURE - GRADIENT DRILL HOLES

SODA LAKE AREA

CHURCHILL COUNTY, NEVADA

APRIL, 1979 RENO, NEVADA



TOPOGRAPHIC BASE TAKEN FROM SODA LAKE 15' U.S.G.S. QUADRANGLE

REVISIONS		DATE
UPDATED	TMP	4/80

▲ TEMPERATURE - GRADIENT HOLE
△ TEMPERATURE PROBE, STRAT. TEST
ABANDONED LOCATION
SHUT IN PRODUCER
○ LOCATION OR DRILLING WELL

2000' 0 2000' 4000' 6000' 8000'
SCALE 1" = 2000'

PHILLIPS PETROLEUM COMPANY
BARTLESVILLE, OKLAHOMA
NATURAL RESOURCES GROUP
ENERGY MINERALS DIVISION

ESTIMATED DEPTH TO 400°F
SODA LAKE AREA
CHURCHILL COUNTY, NEVADA
APRIL, 1979 RENO, NEVADA

PLATE 5

PLATE 6

SODA LAKE AREA